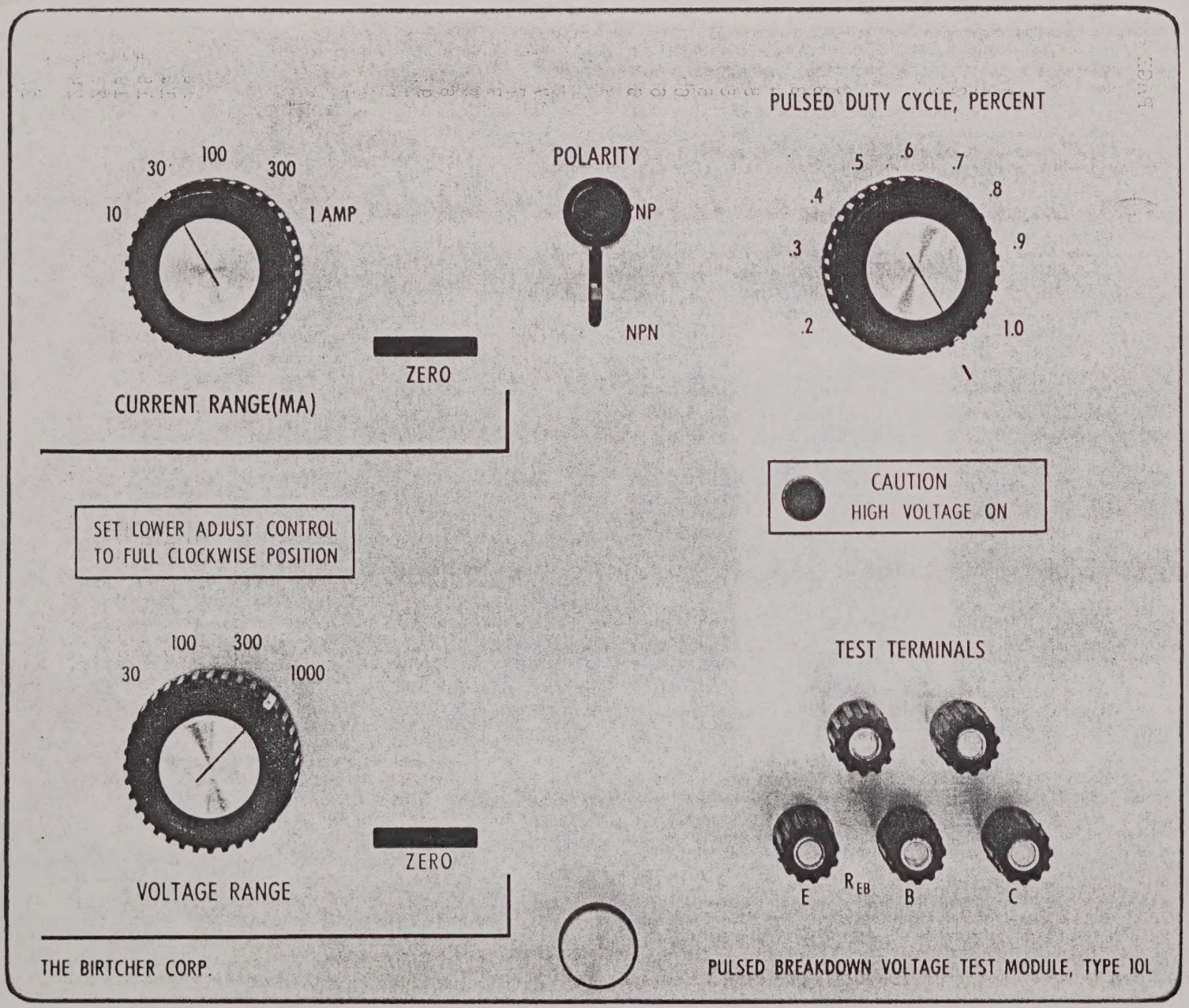
Birtcher
Type 10L
Transistor Pulsed
Breakdown
Voltage Test Module

MC 724

TYPE 10 L

TRANSISTOR PULSED BREAKDOWN
VOLTAGE TEST MODULE


PULSED DUTY CYCLE, PERCENT
POLARITY
10
30
100
300
1 AMP
PNP
NPN
.2
.3
.4
.5
.6
.7
.8
.9
1.0
ZERO
CURRENT RANGE(MA)
CAUTION
HIGH VOLTAGE ON
SET LOWER ADJUST CONTROL
TO FULL CLOCKWISE POSITION
30
100
300
1000
TEST TERMINALS
ZERO
VOLTAGE RANGE
E
R_{EB}
B
C
THE BIRTCHER CORP.
PULSED BREAKDOWN VOLTAGE TEST MODULE, TYPE 10L

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SECTION 1

GENERAL DESCRIPTION

1.1 GENERAL

The Birtcher Model 10L Plug-In Module is used with the Birtcher Model 70 basic unit to perform pulsed breakdown tests of transistors into the latch-up, or sustain, voltage breakdown region. The 10L module is suitable for any semiconductor breakdown test permissable with a load-line, or series resistance, type of test.

The low variable duty cycle feature of the 10L permits measurement of high peak currents in the breakdown region with a minimum of possibility of junction heating and damage.

1.2 SPECIFICATIONS

Parameters Measured:

LV_{CEO}, LV_{CER}, LV_{CES}, BV_{CEO}, BV_{CER}, BV_{CES}, (LV_{CEX} can be made by use of external voltage source).

Current Ranges:

10, 30, 100, 300 milliamperes, 1 ampere, ± 2% of full-scale.

Test Potential:

Continuously variable 0 to 1000 volts, peak. Limiting action by series resistance to approximately 500 volts peak at full-scale of any current range.

Voltage Measurement Range:

30, 100, 300, 1000 volts, ± 3% of full-scale.

Duty Cycle:

Continuously variable, 0.2 to 1.0 per cent at 60 CPS line frequency. (0.17 to 0.89 per cent at 50 CPS line frequency).

Test Pulse Width:

Continuously variable, 33 to 167 microseconds.

Construction:

Aluminum alloy chassis, anodized aluminum front panel with three color markings, colors coded for operational use.

Weight:

8 pounds.

Dimensions:

8 1/2" wide x 7" high x 13" deep.

1.3 SEMICONDUCTOR CONNECTIONS

Due to the short pulse times involved, the semiconductor under test is connected to the module test jacks, rather than to the basic unit test jacks. The binding posts employed as test jacks are suitable for connection of shorting bars, resistors, or oscilloscope connections when used with Birtcher Test Adapters.

Birtcher Test Adapters suitable for use with the 10L Module are:

#5529 - Universal use (clip leads) for transistors and diodes.

#5538 - Long lead, small case transistors.

#5559 - TO-3 Packages

#5560 - TO-36 Packages

#5561 - TO-18 Packages

#5562 - MS-3 Packages

#5597 - Diode and SCR

1.4 HIGH VOLTAGE PRECAUTIONS

The high peak voltages present at the 10L module test jacks can be dangerous to the operator. Although the high voltages occur in short intervals, they have great shock potential.

The binding post test jacks are well insulated and a high voltage warning lamp is included in the panel display, but many semiconductors are made with one junction made to the case and are thus susceptable to contact by the operator.

For the sake of safety, the cautions presented in the operation section must be observed.

SECTION 2

OPERATION

2.1 CONTROLS

2.1.1 Color Coding

The controls of the basic unit and module are grouped and color-coded for their basic functions. The black-marking controls are for current control and measurement; the red-marking controls for voltage control and measurement; the blue-marking controls for polarity, duty-cycle control, and test connections.

2.1.2 Front Panel Control Description

Basic Unit UPPER METER:

Reads pulse current through semiconductor under test.

Basic Unit UPPER ADJUST Control:

Sets magnitude of current through semiconductor under test.

CURRENT RANGE Selector Switch:

Selects range of current measurement as read out on basic unit UPPER METER.

Black-Marking ZERO Thumbwheel:

Sets electrical zero of current meter.

Basic Unit LOWER METER:

Reads pulse voltage across semiconductor under test.

Basic Unit LOWER ADJUST Control:

Sets supply voltage for pulse generator output circuit - this control set to full clockwise position for tests with the 10L module.

VOLTAGE RANGE Selector Switch:

Selects range of pulse voltage read out on basic unit LOWER METER.

Red-Marking ZERO Thumbwheel:

Sets electrical zero of voltmeter.

POLARITY Selector:

Connects proper terminals of semiconductor under test to 10L circuitry.

DUTY CYCLE Control:

Sets the pulse width of the test pulse applied to the semiconductor under test.

High Voltage WARNING LAMP:

Lamp lights when basic unit TEST switch is in TEST position to warn operator of high voltage present at test jacks.

Basic Unit OVERLOAD Lamp:

Not used with the 10L module.

Basic Unit POWER SWITCH:

Turns on basic unit and module.

2.2 PRELIMINARY OPERATION PROCEDURE

2.2.1 Semiconductor Connections

The semiconductor under test is connected to the 10L module TEST JACKS in the banana-plug portion of the binding post. Shorting links or base-emitter resistors are connected between the emitter and base binding posts in the space marked "R_{EB}".

The upper two binding posts are internally jumpered to the "E" and "C" terminals. The upper terminals are used with diode test adapters.

2.2.2 Safety Precautions

To increase safety, it is recommended that Birtcher Test Adapters (listed in paragraph 1.3) are used. With certain transistors, the full test potential is present at the transistor case. This is true with PNP transistors having a collector-to-case internal connection.

The operator's hands must be clear of the transistor case or leads, whenever the HIGH VOLTAGE WARNING LAMP is on, or when the TEST switch is depressed.

2.2.3 Turn-On and Warm-Up

2.2.3.1 Turn on the basic unit POWER SWITCH and allow the set to warm up for a few minutes.

2.2.3.2 Zero the meter needles with the ZERO thumbwheels.

2.2.3.3 Set the DUTY CYCLE control for the desired duty cycle.

2.2.3.4 Set the POLARITY switch for the type of transistor under test.

2.2.3.5 Set the UPPER ADJUST control fully counterclockwise.

2.2.3.6 Set the LOWER ADJUST control fully clockwise as per the sign on the 10L module.

2.2.3.7 Re-check the meter zeroes. There will be a slight drift of the zero indication for the first fifteen minutes after turn-on.

2.3 TEST PROCEDURES

2.3.1 General

The following test procedure steps are given with the assumption that the initial turn-on control settings have been made; also that, if required, the base-emitter shorting link, resistor, or external voltage source has been connected.

Three basic measurements are given: Breakdown voltage, latch-up or sustain voltage, and diode peak reverse voltage. A procedure for fast-response zener diodes is also included.

2.3.2 Pulsed Breakdown Voltage

2.3.2.1 Set the CURRENT and VOLTAGE RANGE switches to the desired ranges.

2.3.2.2 Depress the TEST switch and rotate the UPPER ADJUST control clockwise until the desired current is indicated on the UPPER METER.

2.3.2.3 Read the breakdown voltage on the LOWER METER.

2.3.2.4 If the indicated voltage has reached a peak and begun to drop before the desired current was reached, the transistor breakdown curve is approaching the latch-up voltage region.

For Higher Measurements, where Longer Test Pulse Width, it

2.3.3 Pulsed Latch-Up or Sustaining Voltage

2.3.3.1 Set the CURRENT and VOLTAGE RANGE switches to the desired ranges.

2.3.3.2 Depress the TEST switch and rotate the UPPER ADJUST control clockwise until the desired current is indicated on the UPPER METER.

2.3.3.3 The latch-up voltage will be indicated when the LOWER METER peaks and then drops to its lowest reading, all when the UPPER ADJUST control is being moved clockwise.

2.3.3.4 Some transistors have a definite negative resistance portion of its breakdown curve that will cause oscillation. The oscillation will be noticed as erratic readings on the LOWER METER. Since the latch-up portion of the curve is at or near positive resistance, the oscillations will not occur if the UPPER ADJUST control is increased past this point in the curve.

2.3.4 Pulsed Diode Peak Reverse Voltage

2.3.4.1 Connect the diode anode to the upper left post and the cathode to the upper right binding post. Set the POLARITY switch to NPN. Orientation is identical to symbol indicated beside Model 70 jacks.

2.3.4.2 Set the CURRENT and VOLTAGE RANGE switches to the desired range.

2.3.4.3 Depress the TEST switch and rotate the UPPER ADJUST control clockwise until the desired current reading is obtained.

2.3.4.4 Read the reverse voltage on the LOWER METER.

2.3.5 Pulsed Zener Voltage

2.3.5.1 Connect the zener diode as in the diode test and set the RANGE switches as desired.

2.3.5.2 Depress the TEST switch and rotate the UPPER ADJUST control clockwise until the desired current reading is obtained.

2.3.5.3 Read the zener voltage on the LOWER METER.

NOTE: The response of the zener diode may not be fast enough for measurements at low duty-cycles. If in doubt, check the anode-to-cathode voltage with a differential-input oscilloscope; if the voltage peaks fully at mid-pulse, the reading is valid.

SECTION 3

THEORY OF OPERATION

3.1 GENERAL

The 10L module is basically a power pulse generator with current and voltage measuring circuitry. A block diagram of the module is shown in Figure 3-2. Meter read-outs, test control circuits, and AC for the power supplies are contained in the basic unit.

3.2 MEASUREMENT METHOD

A series current-limiting resistance is connected between the pulse generator and the semiconductor under test. This resistance is selected by the CURRENT RANGE switch and has a value sufficient to drop approximately 500 volts of the pulse amplitude at full-scale current.

The series resistance generator configuration permits measurement of devices having negative resistance response. A typical breakdown curve of a transistor is shown in Figure 3-1 (A). As can be seen, the slope of the curve is positive up to the breakdown point; at increased current beyond this point, the voltage drops until the latch-up voltage value is reached. The slope is negative between these two points on the curve.

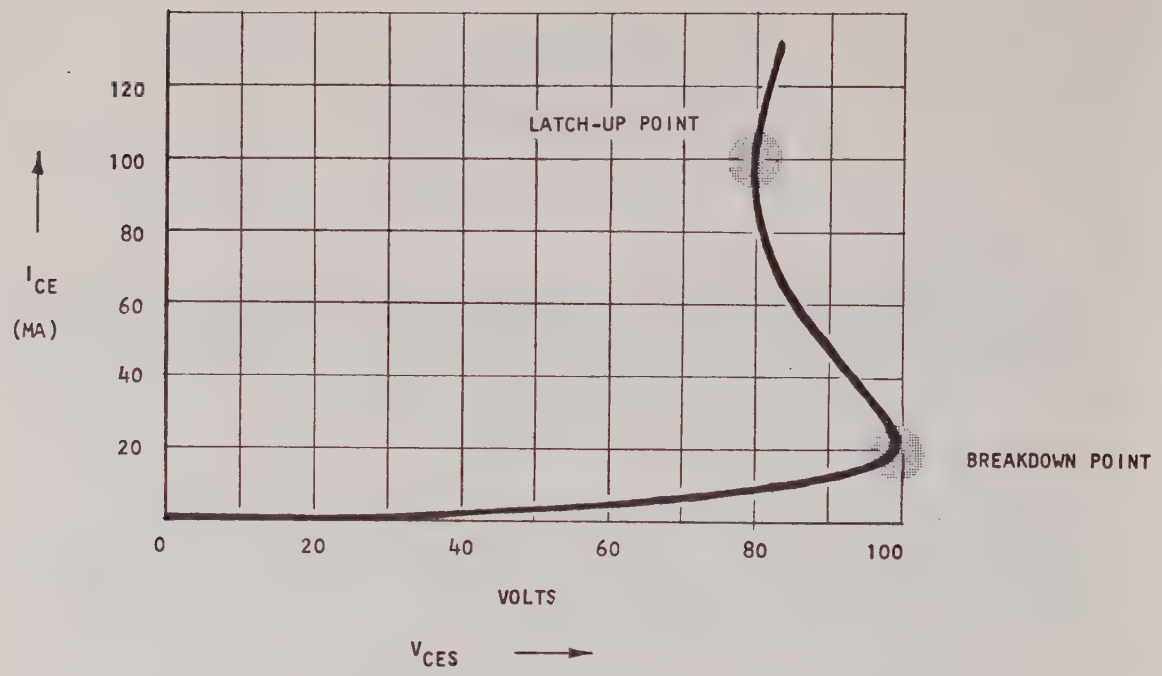
Figure 3-1 (B) illustrates, in simple block form, the essential circuitry of the module's pulse generator, series resistance, and a PNP transistor connected for LV_{CES}. The voltages and currents shown on (B) correspond to points on the breakdown curve of (A). Note that the voltage across the device drops in the negative resistance portion of the curve even though the amplitude of pulse generator keeps increasing.

If the transistor under test has a negative slope and sufficiently great junction capacitance, a relaxation oscillator will be formed in the transistor. The rise and fall time of the pulse generator has been made fast enough so that oscillation will be minimized when the peak of the test pulse is beyond the negative-resistance portion of the curve.

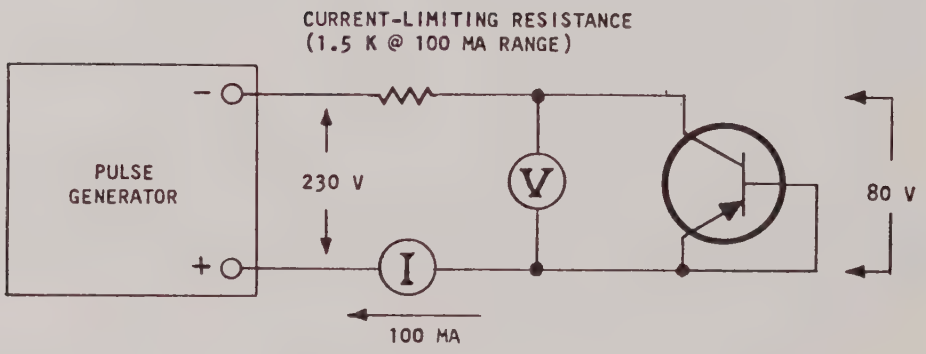
3.3 GENERAL CONFIGURATION OF MODULE

Figure 3-2 illustrates the basic blocks of the 10L module. Circutis located in the Model 70 basic unit are shown in grey.

The pulse generator is composed of two parts, the synchronizer and the amplifier. The synchronizer, solid-state and mounted on the printed circuit board, locks the repetition rate to the line frequency, forms the test pulse width, and generates a "strobe" or sampling pulse for the voltage and current measureing circuits.



(A) TYPICAL TRANSISTOR BREAKDOWN CHARACTERISTIC



(B) ESSENTIAL CIRCUIT DIAGRAM, 10 L MODULE

FIGURE 3-1

TYPICAL CHARACTERISTIC CURVE AND ESSENTIAL CIRCUIT DIAGRAM

The test pulse width is manually adjustable from 33 to 167 microseconds giving a duty cycle of 0.2 to 1.0 per cent at a 60 CPS line frequency. The test pulse output amplitude is controlled in the amplifier by the UPPER ADJUST control.

3.4 PULSE GENERATOR

3.4.1 Pulse Synchronizer

The synchronizer contains a schmitt trigger, three 1-shot multivibrators, two buffer amplifiers, and a transformer-coupled strobe pulse output amplifier.

The strobe delay 1-shot has a width of approximately half that of the test pulse 1-shot. Since both 1-shots are controlled in width by the same control, the beginning of the strobe pulse for the measuring circuits will always occur in the middle of the test pulse.

3.4.2 Schmitt Trigger

The one-shot multivibrators require a fast-rise trigger to turn on. The schmitt trigger, composed of Q1 and Q2, squares off the 6.3 VAC sine-wave filament voltage to provide the triggering for the test pulse and strobe delay 1-shots.

In the quiescent condition, Q2 is conducting heavily; Q2's collector-emitter current is dropped across R8. This drop keeps the emitter of Q1 raised above ground so that the base bias from R2 and R3 is only enough to allow slight conduction of Q1. Since Q1 is conducting only slightly, its collector voltage is nearly at supply potential; Q2 continues to conduct heavily by base current through R5 from the collector of Q1.

When the filament voltage waveform swings negative, base current to Q1 is supplied through R1. Q1 conducts, dropping its collector voltage. The drop in collector voltage drops the base current in Q2 causing it to go nearly to cutoff. The conduction current from Q1 also flows through R8, keeping Q2's base. This stable condition persists as long as a negative voltage is present at the base of Q1.

When the filament voltage swings back towards zero, Q1 goes out of conduction causing its collector voltage to rise; the emitter of Q2 drops and the combined result of that and increased base current is that Q2 quickly goes into conduction.

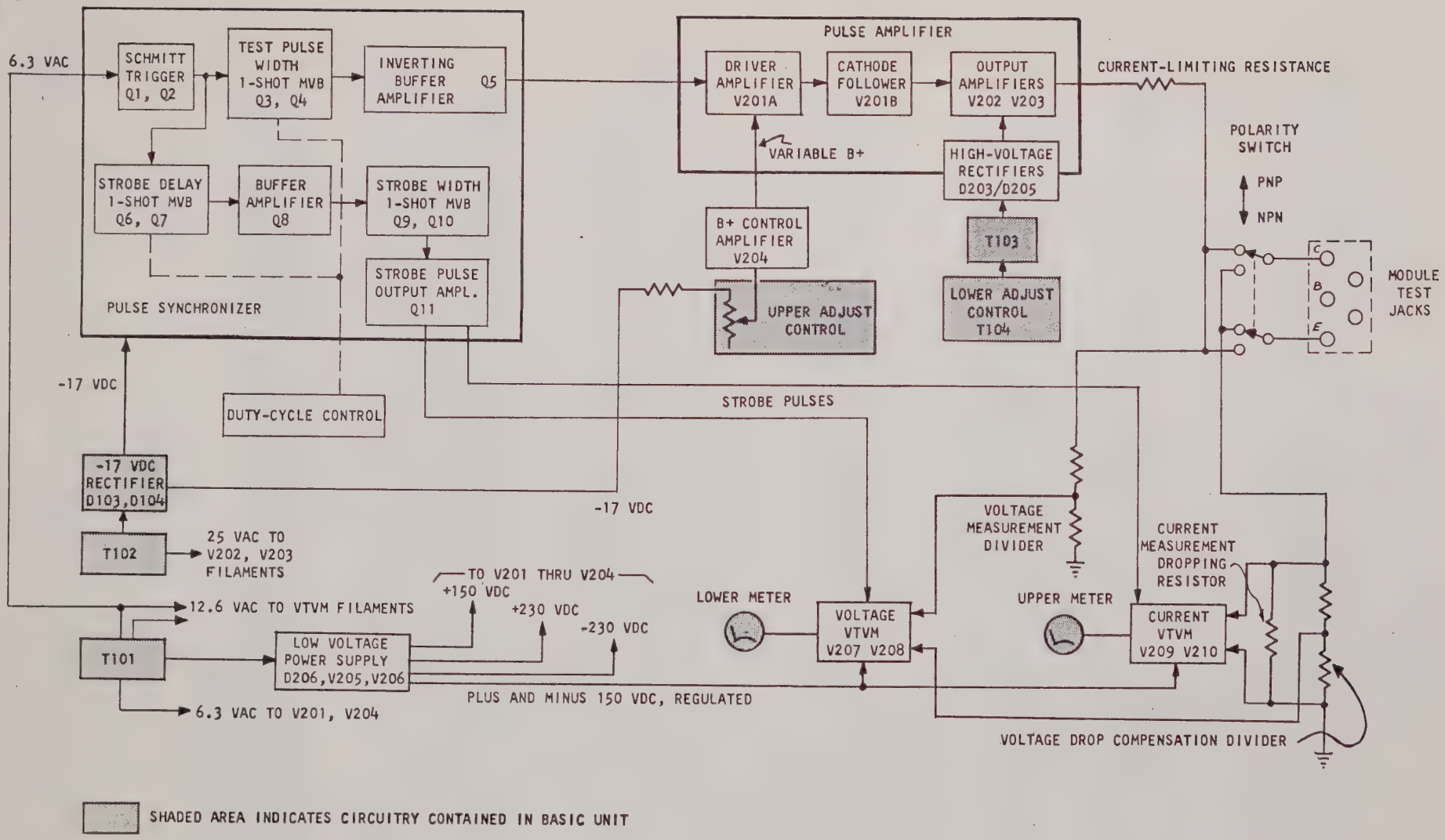


FIGURE 3-2

10 L BLOCK DIAGRAM

The square wave output of Q2 has sharp rise and fall times. C2 and R9 differentiate the leading and trailing edges to form spikes. The spikes are coupled through D1 and D2 to the 1-shots. R10 and R11 prevent interference between the multivibrators.

3.4.3 One-Shot Multivibrators

The strobe delay 1-shot is taken as the typical example. Except for minor variations, all three multivibrators work the same.

In the quiescent condition, Q7 is conducting. Its collector is bottomed to the $V_{CE(SAT)}$ level and very little base current through R24 and the duty cycle potentiometer to -6 volts.

A negative trigger pulse through D11 caused Q6 to conduct, dropping its collector voltage to the saturation level. The drop in collector voltage is coupled to the base of Q7 through C8, causing Q7 to cut off.. When Q7 cuts off, its collector voltage rised, permitting base current to flow into Q6 through R23 keeping Q6 in conduction.

When Q6 snapped into conduction, the charge of C8 was changed, giving a positive potential at the base of Q7. The positive potential at the Q7 base remains until C8 discharges fully through R24 and the duty cycle potentiometer. Q7 will begin conduction when the positive potential approaches near-zero voltage. When Q7 conducts, its collector bottoms at saturation and base current for Q6 through R23 ceases, cutting off Q6. The off time of Q7 is thus controlled by the time constant of C8, R24, and the duty cycle potentiometers.

Diodes D6 and D7 clamp the negative-going collector voltages for stability. The diode clamp voltage of -6 volts is derived by R19 and zener diode Z1 from the -17 VDC supply. R21 and C7 form a decoupler for D6 and D7 to prevent transients from inadvertently triggering the one-shot.

C9 helps speed up the switching of Q6's base bias. Q8 is a simple, saturating inverting amplifier used as a buffer. R35 and C16 decouple the -6 volts to the duty cycle control potentiometer.

In the test pulse width 1-shot, the time-constant coupling capacitor is made up of C3 and C215, an external variable capacitor. C215 is made variable in order to calibrate the width of the test pulse. The positive-going pulse from the collector of Q3 is inverted in buffer Q5 to form a negative pulse at the input of the pulse amplifier section.

The strobe pulse 1-shot is triggered from the trailing edge of the strobe delay pulse through differentiator C11 and R27 and the coupling diode D8. Strobe amplifier Q11 forms two isolated strobe pulses with pulse transformer T1. D5 damps out any ringing in T1.

3.4.4 Pulse Amplifier Driver

The pulse amplifier driver consitst of amplifier V201 and its control tube, V204. V201A is a conventional pentode amplifier direct coupled to cathode follower V201B. The cathode resistors and grid return of V201 are returned to -230 volts in order to provide cut-off bias for the output stage grids.

The B+ for the pentode stage is supplied from cathode follower V204B. V204B is fed by DC amplifier V204A. The input for V204A is from a voltage divider composed of R241 and the UPPER ADJUST control changes the input signal to V204A; the amplified signal sets the cathode voltage of V204B. DS202 through DS204 provide a constant potential of approximately 170 volts for coupling without loss of gain.

The variable B+ on the plate of V201A gives a variable peak pulse voltage out of that stage. The variavle peak pulse allows control over the amplitude out of the output stage. Variation of the B+ for V201A will also change the quiescent voltage into the output stage, but the circuit constants are chosen so that the least negative quiescent voltage is below the cutoff voltage for the output tubes.

3.4.5 Pulse Amplifier Output Stage and Power Supply

Output tubes V201 and V203 are better described as switches for discharging C203 and C204. Figure 3-3 a simplified schematic of the output stage, illustrates the output pulse formation.

Capacitors C203 and C204 are charged to approximately 1000 volts by diodes D212, D213, and D214 through R210 and charge-by-pass diodes D201 and D202. Since the semiconductor under test appears across the charge-by-pass diodes, the only voltage present results from the charging current voltage drop through diodes, approximately 1 1/2 volts. The charging current is actually a pulse that varies in width from about a tenth to a twentieth cycle of the line frequency.

When V202 and V203 receive a positive pulse sufficient to turn them on, a low-resistance path from cathode to anode is created. The low-resistance caused C203 and C204 to discharge through the semiconductor under test and resistors R214 and R215. D201 and D202 are cut off by the polarity of the voltage drop across R214 and R215; the inductance of T103's secondary prevents excessive surges through D213 to D215.

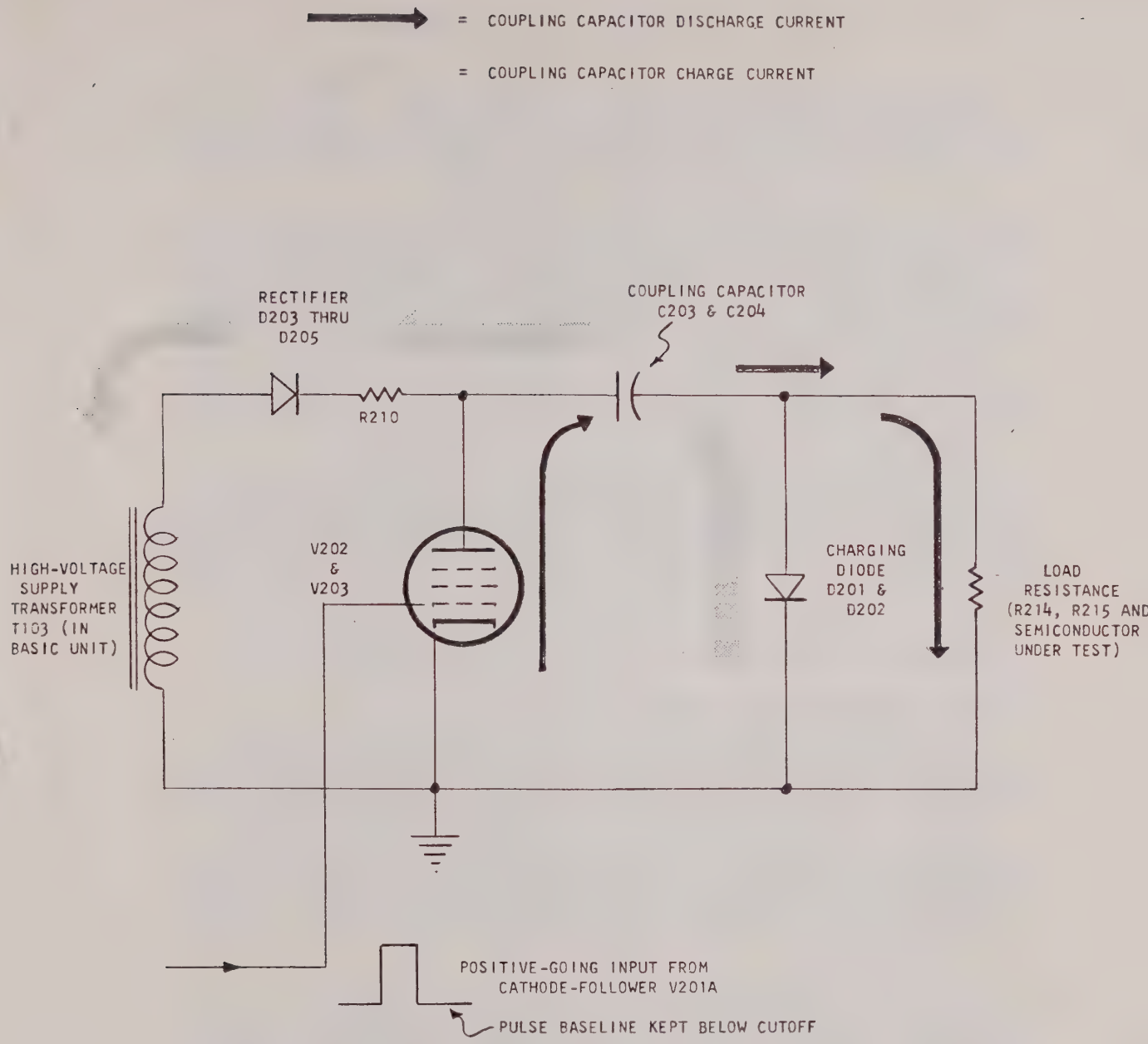


FIGURE 3-3

OUTPUT STAGE SIMPLIFIED SCHEMATIC

Since the cathode-plate resistance of the output tubes can be varied by the grid voltage, the variable peak pulse from cathode follower V201B causes a variable discharge pulse current in the semiconductor under test.

R206 and R207 are used to prevent parasitic effects and to balance the grid voltages when the grids are driven into the positive voltage region. R208 and R209 balance the screen currents during conduction. R211 discharges C203 and C204 when the test relay K201 is de-energized.

3.5 MEASUREMENT CIRCUITRY

3.5.1 General

The measurement circuitry consists of two sampling, or strobed, differential vacuum tube voltmeters and their associated voltage dividers and voltage dropping resistors. The VTVMs are identical but their input circuits are different

Current limiting for the semiconductor under test and polarity control will also be covered in this section.

3.5.2 Semiconductor Test Connections

Since the parameters to be measured involve only two terminals, the emitter and collector leads are switched for PNP or NPN, rather than swtiching the generator and measuring circuits. Current limiting resistors R216 through R220 drop the generator voltage approximately half when the semiconductor current is full-scale at any selected range. The limiting resistors also permit measurement of voltage across the semiconductor when the breakdown curve slope is negative.

3.5.3 Current Measurement

Dropping resistors R229 through R233, selected by CURRENT RANGE switch section S201B and S201C, supply a negative one volt peak for the current VTVM when the semiconductor test current is full scale at any range. The extra switch section, S201C, is used to prevent error caused by contact resistance in S201B.

3.5.4 Voltage Measurement

R221 through R226, C205, and VOLTAGE RANGE switch section S202A form a variable voltage divider to supply the voltage VTVM with one volt peak negative at any range full-scale. C205 is used to compensate for differences in residual capacitance across any resistor by rounding off the leading and trailing edges of the divided test pulse.

Since there is at least a 16 microsecond delay between the start of the test pulse and the actual start of measurement by the VTVM, the round-off action does not affect the accuracy of measurement.

The return of the current sampling resistor and the return of the voltage divider are goth to ground. The voltage divider thus sees both the semiconductor voltage and the current sampling resistor drop. If the current sampling resistor drop is not compensated for, a +3% error in indicated voltage is possible with indicated current at full-scale and the voltage range at 30 volts. This error is compensated by voltage divider R234 through R237, C207, and switch S202B. The divider is across the current sampling resistor and feeds the other grid of the voltage VTVM.

The VTVM is corrected for the up-scale error by the fact that the compensating divider picks off a negative voltage which is fed to the opposite grid of the VTVM. The negative input to the opposite grid (pin 7) causes a down-scale indication. C207 is used for compensating residual capacitance in the divider resistors.

3.5.5 Vacuum-Tube Voltmeters

Since both VTVMs are identical, the voltage measuring VTVM is described as typical of both circuits. The VTVM consists of the input cathode follower, diode bridge switch and output cathode follower. The followers are arranged for differential operation.

V207A and V207B form the input cathode followers. R250 is a front panel zero adjust control for equalizing the quiescent cathode output voltage between section A and section B.

The diode bridge formed by D207 through D210, in conjunction with the strobe pulse, acts as a sample gate. When the strobe pulse is present, all four diodes are switched to low-resistance forward conduction, allowing C212 to charge to the V207 cathode differential voltage. After several strobe repetitions, C212 will charge to nearly the full voltage differential. The discharge path of C212 is blocked by zener diode Z201.

The cathode followers act as a high input impedance VTVM reading the voltage across C212. Voltage is indicated on the basic unit meter. Calibration adjustments are made by R259 in series with the meter.

3.6 POWER SUPPLY

3.6.1 Synchronizer Supply

T102, D104, D103, and C103 in the basic unit, form a simple bridge rectifier to supply -17 VDC for the pulse synchronizer.

3.6.2 Vacuum Tube Voltmeter Supply

The high-voltage winding of T101 in the basic unit feeds bridge rectifier D206 in the module. The D206 assembly is used as two full-wave rectifiers in a single package; sections A and C of D211 conduct during positive half-cycles from T101 and sections B and D conduct during negarive half-cycles.

C208A and C209 filter the peak AC from D206. Glow-regulators V205 and V206 and dropping resistors R245 and R247 provide regulated +150 and -150 volts for the VTVMs.

3.6.3 Pulse Amplifier Supply

The voltage across C208A and C209 is about +230 and -230 volts respectively. R243 and R242 form a divider to supply approximately +150 volts to the screens of V203 and V202 and to the plate of cathode follower V204B. C208B smooths out the peak voltages caused by high screen current demands during the test pulse duration.

R244 and C206 provide additional filtering of the -230 volts from D211 to supply the cathodes of V201 and the grid of V204B.

3.6.4 Filament Supplies

T102 supplies 25 VAC for the filaments of V202 and V203. R239 and R240 drop the 25 VAC to 22 VAC required by the tubes.

T101 supplies two separate AC lines to the remainder of the vacuum tubes. The 12.6 VAC line for the VTVM filaments V207 through V210 is balanced to ground; one side supplies line frequency AC for triggering the pulse synchronizer. V201 and V204 are made to the 6.3 VAC line which is elevated to -150 VDC.

3.7 TEST CONTROL

The basic unit protection circuit and TEST switch supply 6 VDC for relay K201 in the module. The protection circuit is ·ed only as a relay supply.

K201A connects the output amplifier coupling capacitors to the 1000 volt supply in the TEST, or energized, position. When the relay is energized (RESET position), the contacts discharge the capacitors through a 10K resistor, R211.

The K201B contacts supply +230 VDC to the plate of V204A in the TEST position. In the RESET position, the V204A plate is grounded and the control voltage for the pulse amplifier driver is kept below the cutoff value of the output tubes.

SECTION 4

MAINTENANCE

4.1 INSTRUCTION MANUAL

A Birtcher Instruction Manual sometimes contains hand made changes to diagrams and parts lists, and sometimes texts. These changes are generally appropriate only to the instrument for which the manual was prepared. These hand-made corrections show changes to the instrument that have been made after the printing of the manual.

4.2 REPLACEMENT PARTS

4.2.1 Standard Components

Birtcher will supply replacement components at current net prices. However, since most of the components are standard electronic and radio parts, you can probably obtain them locally faster than we can ship them to you from our factory in Monterey Park, California. Be sure to consult the parts list to see what tolerances are required.

4.2.2 Selected Components

We specially select some of the components whose values must fall within prescribed limits. By sorting through our regular stocks the components so selected will have standard RETMA color coding showing the value and tolerance of the stock they were selected from, but they will not in general be replaceable from dealer stock.

4.2.3 Birtcher Manufactured Parts

Birtcher manufactures almost all of the mechanical parts and some of the components used in the instrument. If you order a mechanical part be sure to describe the part completely to prevent any unnecessary delay in filling your order. When you have any questions about mechanical parts or Birtcher manufactured components, contact our nearest field sales representative or write to the service department at the factory in Monterey Park, California.

4.3 REMOVAL AND REPLACEMENT OF PARTS

4.3.1 Switches

Single wafers are normally not replaced in the rotary switches used in the 10L. If one wafer is defective, the entire switch should be replaced. The switches listed in the parts list are unwired; wired switches may be ordered from Birtcher if desired.

4.3.2 Printed-Circuit Board Components

To avoid damage to the PC board components, the following cautions should be observed:

Use a low power soldering iron (50 watts maximum).

Use only a high quality rosin core solder. Never a paste flux. After soldering, clean off any excess flux.

Heat sink the leads of any semiconductors adjacent to the component being removed.

4.3.3 Component Access

The pulse generator driver, high-voltage rectifier, and low-voltage supply circuits are normally hidden by the synchronizer printed-circuit and support bracket. The bracket is hinged at the rear and may be swung away from the chassis.

To swing the bracket, remove the 6-32 screws on the chassis top that secure the forward bracket mounting stand-off posts; the screws are identified by the flat washers under the screw heads. The stand-off posts should remain attached to the support bracket.

The printed-circuit board is removed from the bracket by removing the screws at the corners of the board.

4.4 CALIBRATION

4.4.1 Preliminary

The 10L Test Module is a stable instrument and should not require frequent calibration. However, it will be necessary to calibrate certain parts of the instrument when tubes or components are changed. A periodic calibration check is desirable from the standpoint of preventive maintenance.

The following equipment is necessary for a complete calibration of the 10L module:

1. DC voltmeter capable of measuring 30.0 volts and 1.00 volts $\pm$ 0.1%, 5000 ohms per volt or greater input impedance, Fluke Model 825A differential voltmeter or equivalent.

2. Stable DC power supply, variable 0-30 volts, 10 ma minimum.

3. Wide-band oscilloscope capable of measuring 1 to 1000 volts peak, with calibrated 2 msec/cm, 5, 10, and 20 usec/cm sweep rates, Tektronix 530 or 540 series with type C/A plug-in or equivalent.

4. 2.7K, 1 watt resistor.

Connect the 10L module to the Model 70 basic unit with a B-5536 test cable. If the test cable is not available, remove the cabinet of the Model 70 and install the module directly. Mechanically zero all meters.

4.4.2 Test Pulse Width Calibration

1. Set the DUTY CYCLE control to its maximum clockwise position and align the knob so that its index line coincides with the reference mark on the panel. The reference mark is the unmarked line just below the "1.0" mark.

2. Set the remaining controls as follows:

TEST SWITCH	RESET
ADJUST CONTROLS	CW
VOLTAGE RANGE	1000 VOLTS
CURRENT RANGE	1 AMP
POLARITY	PNP

3. Connect the oscilloscope vertical input to the "C" binding post on the module and the oscilloscope ground to the module chassis ground. Set the oscilloscope controls as follows:

VERTICAL SENSITIVITY	200 V/CM
INPUT MODE	DC
SWEEP TIME	20 USEC/CM
SWEEP TRIGGER	INTERNAL, NEGATIVE

4. Turn on Model 70 power switch and allow a few minutes warm-up.

5. Depress the TEST switch. A negative pulse of approximately 1000 volts peak should be present.

6. Adjust the width of the pulse with the padder capacitor mounted on the printed-circuit board hinged bracket. The width should be 167 usec, or 8.35 CM at 20 usec/CM.

7. Turn the duty cycle control to "0.2". The width of the pulse should be 33 ± 5 microseconds.

8. Turn the duty cycle control to "0.6". The width of the pulse should be 100 ± 16 microseconds.

4.4.3 Voltmeter Calibration

1. Connect the power supply and DC voltmeter positive lines to the module ground. Connect the power supply and DC voltmeter negative lines to the module "C" binding post.

2. Set the basic unit and module controls as follows:

TEST SWITCH	RESET
ADJUST CONTROLS	CCW
CURRENT RANGE	1 AMP
VOLTAGE RANGE	30 VOLTS
POLARITY SWITCH	PNP

3. Turn on the Model 70 power switch and allow a few minutes warm-up.

4. Set the ZERO thumbwheel for zero meter indication.

5. Turn on the external DC power supply and set it for exactly 30.0 volts.

6. Adjust potentiometer R259 marked "VOLTAGE CALIBRATE" on the module chassis for full-scale deflection on the LOWER METER.

7. Repeat steps 4.4.3.4 through 4.4.3.6 to check that the zero has not drifted.

NOTE: Do NOT depress the TEST switch on this calibration - it may damage the external equipment.

4.4.4 Current Meter Calibration

4.4.4.1 Connect the power supply and DC voltmeter positive lines to the module ground. Connect the DC voltmeter negative line directly to the "C" binding post of the module. Connect the power supply negative line in series with the 2.7K resistor to the "C" binding post.

Connect Coha 355 output terminals as follows
+ Terminal to (10L module) Terminal "C"
- Terminal to (10L module) Chassis Ground
Adjust 355 for 1.000000 volt output

4.4.4.2 Set the basic unit and module controls as follows:

TEST SWITCH	RESET
ADJUST CONTROLS	CCW
CURRENT RANGE	10 MA
VOLTAGE RANGE	1000 VOLTS
POLARITY SWITCH	NPN

4.4.4.3 Turn on the Model 70 power switch and allow a few minutes warm-up.

4.4.4.4 Set the ZERO thumbwheels for zero meter indication.

4.4.4.5 Adjust the power supply for exactly 1.00 volt indication on the external voltmeter.

4.4.4.6 Adjust potentiometer R269, marked "CURRENT CALIBRATE", on the module chassis for full-scale deflection on the UPPER METER.

4.4.4.7 Repeat steps 4.4.4.4 through 4.4.4.6 to check for meter zero.

4.5 TROUBLESHOOTING

4.5.1 Symptom Analysis

Typical voltages are included in the schematic diagram. Most of the circuitry is straightforward and needs little explanation. The more complex troubles are tabulated in the following chart:

SYMPTOMS	CAUSE	CHECK
Meter zero drifts in slow, random manner; pulse output normal.	Loss of strobe pulse.	Pulse synchronizer strobe delay and width multivibrators, or associated buffer amplifiers.
No pulse output, random zero drift, all components appear good.	Loss of triggering.	Pulse synchronizer, Schmitt trigger.
No pulse output, zero setting good, all components appear good.	Loss of pulse drive.	Pulse synchronizer width multivibrator or V201, V204.
No pulse output, zero setting good, R210(470 ohm, 1/2 Watt resistor under V203)burned out.	C203 or C204 shorted, V202 or V203 bad, or loss of negative bias for V202 or V203.	C203, C204, V202, V203, V201 and V204 circuitry.
Pulse output maximum about half at one ampere loads (will appear normal at light loads).	V202 or V203 inoperative.	V202 or V203
Voltage or current reading no greater than half-scale, maximum; reading appears to be compressed at maximum. Pulse output normal.	Shorted diode in diode bridge switch.	Bridge switch diodes (May be checked in-circuit).
Voltage or current reading drops when duty cycle control turned down; pulse output normal.	Diode in bridge switch has poor recovery time or strobe position not correct.	Bridge switch diodes (sequentially substitute new diodes) or check strobe (paragraph 4.5)
Voltage or current zero setting not possible, pegged at either extreme.	VTVM tubes, +150 volts, or -150 volts supply inoperative.	Affected-circuit tubes or power supply.
Voltage and current indication rise slightly when DUTY CYCLE control is turned down.	Normal operation, output pulse has slight droop.	----------

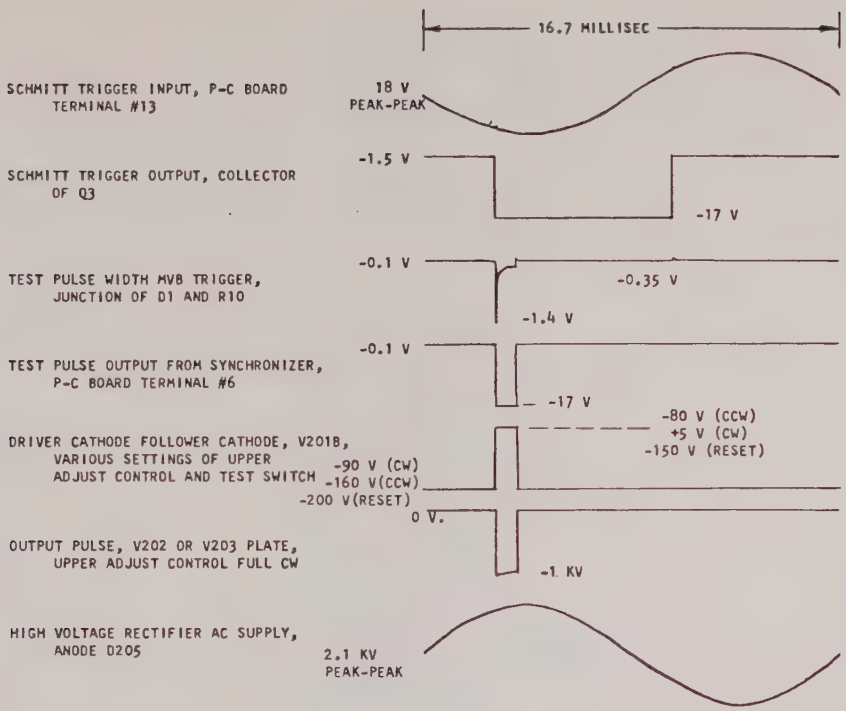
4.5.2 Waveforms

Figure 4-1 illustrates the 10L waveforms in proper time sequence.

4.6 PREVENTIVE MAINTENANCE

In addition to periodic calibration checks, the vacuum tubes should be checked. Re-calibration is required if the VTVM tubes or glow-regulators are replaced.

The cooling fan, motor, and chassis area should be cleaned from time to time. Lubrication of the motor is required only every 3 to 6 months; use only a few drops of premium grade SAE 20 to 30 oil in the felt bearing pads - DO NOT USE A GREASE.


16.7 MILLISEC
SCHMITT TRIGGER INPUT, P-C BOARD TERMINAL #13
18 V PEAK-PEAK
SCHMITT TRIGGER OUTPUT, COLLECTOR OF Q3
-1.5 V
-17 V
TEST PULSE WIDTH MVB TRIGGER, JUNCTION OF D1 AND R10
-0.1 V
-0.35 V
-1.4 V
TEST PULSE OUTPUT FROM SYNCHRONIZER, P-C BOARD TERMINAL #6
-0.1 V
-17 V
DRIVER CATHODE FOLLOWER CATHODE, V201B, VARIOUS SETTINGS OF UPPER ADJUST CONTROL AND TEST SWITCH
-80 V (CCW)
+5 V (CW)
-150 V (RESET)
-90 V (CW)
-160 V(CCW)
-200 V(RESET)
0 V.
OUTPUT PULSE, V202 OR V203 PLATE, UPPER ADJUST CONTROL FULL CW
-1. KV
HIGH VOLTAGE RECTIFIER AC SUPPLY, ANODE D205
2.1 KV PEAK-PEAK

SYNCHRONIZER WAVEFORMS, DUTY-CYCLE CONTROL SET TO 1.0

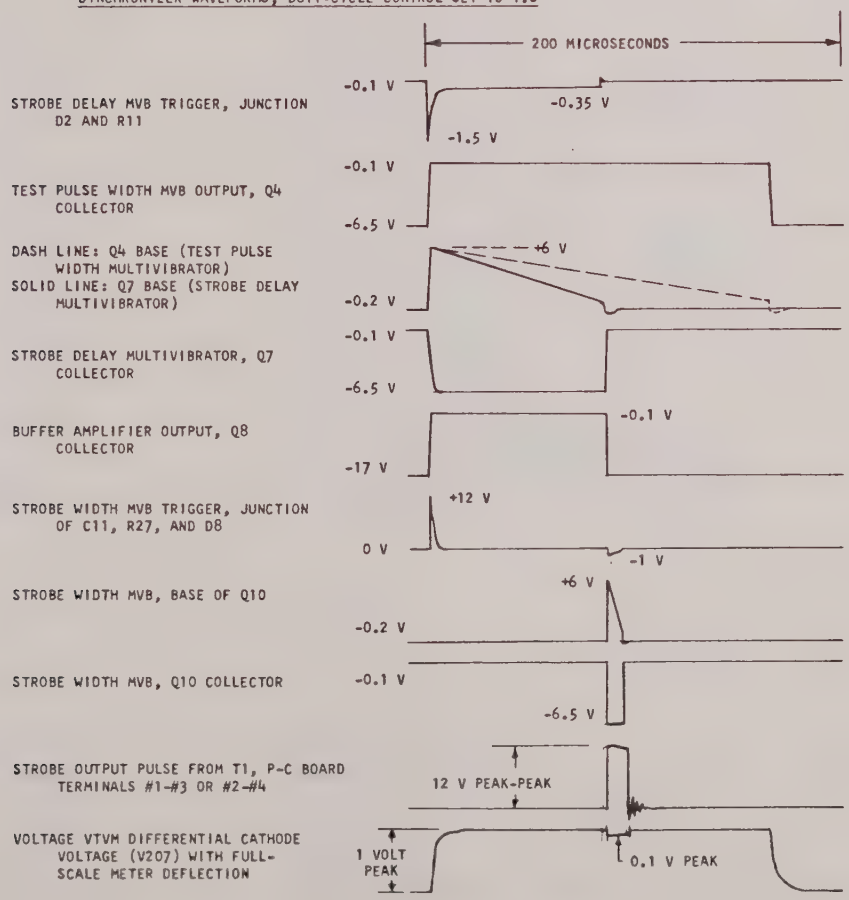


FIGURE 4-1

WAVEFORMS AND TIMING CHART

SECTION 5

PARTS LIST

REFERENCE DESIGNATION	DESCRIPTION	BIRTCHER PART NO.
CAPACITORS		
C1	180 pfd, Disc	100-028
C2	150 pfd, Disc	100-027
C3	5100 pfd, ± 2%, Mica	101-079
C4	150 pfd, Disc	100-027
C5	0.1 ufd, Disc	100-076
C6	150 pfd, Disc	100-027
C7	0.1 ufd, Disc	100-076
C8	3600 pfd, ± 2% Mica	101-078
C9	150 pfd, Disc	100-027
C10	150 pfd, Disc	100-027
C11	150 pfd, Disc	100-027
C12	510 pfd, ± 5%, Mica	101-052
C13	0.1 ufd, Disc	100-076
C14	150 pfd, Disc	100-027
C15	150 pfd, Disc	100-027
C201	.01 ufd, Disc	100-075
C202	.01 ufd, Disc	100-075
C203	20 ufd, 600 V, Electrolytic	104-024
C204	20 ufd, 600 V, Electrolytic	104-024
C205	82 pfd, Disc	100-029
C206	20 ufd, 350 V, Electrolytic	104-016
C207	820 pfd, Disc	100-084
C208	2 x 100 ufd, 350 V. Electrolytic	104-102
C209	50 ufd, 350 V, Electrolytic	104-026
C210	0.1 ufd, Disc	100-076
C211	0.1 ufd, Disc	100-076
C212	0.1 ufd, Disc	100-076
C213	82 pfd, Disc	100-029
C214	0.1 ufd, Disc	100-076
C215	1400-3055 pfd, Variable	105-005
C216	1 ufd, 15 V, Electrolytic	104-015
C217	1 ufd, 15 V, Electrolytic	104-015
DIODES		
D1 Through D10	1N281	740-019
D201	Semtech SC6	740-012
D202	Semtech SC6	740-012
D203	1N3256	740-020
D204	1N3256	740-020
D205	1N3256	740-020
D206	Quad Bridge, Semtech SCBR6	740-009
D207 Through D214	1N662A	740-022

LAMPS

DS201	6.3 V Cartridge Type Dialco 39-6.3-1471	340-003
DS202 Through DS204	Signalite 55ST2S	340-001

RELAYS

K201	DPDT, 6 V Coil	540-006

TRANSISTORS

Q1 Through Q11	2N404	741-005

RESISTORS (1/2 W, ± 1%, Carbon, Unless Otherwise Noted)

R1	22K	550-135
R2	27K	550-128
R3	2.2K	550-079
R4	3.9K	550-083
R5	1.5K	550-080
R6	680	550-062
R7	3.9K	550-083
R8	330	550-051
R9	3.3K	550-077
R10	1K	550-053
R11	1K	550-053
R12	2.2K	550-079
R13	100	550-026
R14	2.2K	550-079
R15	4.7K	550-078
R16	4.7K	550-078
R17	22K	550-135
R18	2.2K	550-079
R19	270, 2W	550-063
R20	2.2K	550-079
R21	100	550-026
R22	2.2K	550-079
R23	4.7K	550-078
R24	4.7K	550-078
R25	22K	550-135
R26	2.2K	550-079
R27	3.3K	550-077
R28	2.2K	550-079
R29	100	550-026
R30	2.2K	550-079
R31	22K, ± 5%	550-138
R32	4.7K	550-078
R33	4.7K	550-078
R34	560	550-065

RESISTORS (1/2 W, ± 1%, Carbon, Unless Otherwise Noted)

R201	1M	550-175
R202	1.2K	550-075
R203	47K, 2W	550-140
R204	27K, 1W	550-139
R205	47K, 1W	550-137
R206	470	550-052
R207	470	550-052
R208	47	550-000
R209	47	550-000
R210	470	550-052
R211	10K, 2W	550-108
R212	1M, 2W	550-188
R213	1M, 2W	550-188
R214	2.7K, 2W	550-090
R215	2.7K, 2W	550-090
R216	47K, 1W	550-137
R217	15K, 1W	550-107
R218	4.7K, 1W	550-089
R219	1.5K, 2W	550-085
R220	350, 5W, WW, Non-Inductive	553-102
R221	29K, ± 0.5%, Film	552-064
R222	70K, ± 0.5%, Film	552-053
R223	200K, ± 0.5%, Film	552-090
R224	1K, ± 0.5%, Film	552-003
R225	350K, ± 0.5%, Film	552-097
R226	350K, ± 0.5%, Film	552-097
R227	47K, 1W	550-137
R228	680K	550-166
R229	100.5, ± 0.5%, WW	553-103
R230	33.3, ± 0.5%, WW	553-054
R231	10.0, ± 0.5%, WW	553-025
R232	3.33, ± 0.5%, WW	553-008
R233	1.00, ± 0.5%, WW	553-007
R234	29K, ± 0.5%, Film	552-064
R235	70K, ± 0.5%, Film	552-053
R236	200K, ± 0.5%, Film	552-090
R237	1K, ± 0.5%, Film	552-003
R238	Dual 25K, ± 10%	554-052
R239	6.8 ohm, 2W, WW	553-029
R240	6.8 ohm, 2W, WW	553-029
R241	1K	550-053
R242	22K, 2W	550-141
R243	6.8K, 2W	550-109
R244	1K	550-053
R245	2.5K, 5W, WW	553-133
R246	100K	550-127
R247	2.5K, SW, WW	553-133
R248	10K	550-101
R249	10K	550-101
R250	2K, Potentiometer	554-027
R251	47K	550-126

RESISTORS (1/2 W, ± 1%, Carbon, Unless Otherwise Noted)

R252	47K	550-126
R253	1K	550-053
R254	470	550-052
R255	470	550-052
R256	100K	550-127
R257	100K	550-127
R258	10K	550-101
R259	10K, Potentiometer	554-026
R260	2K, Potentiometer	554-031
R261	47K	550-126
R262	47K	550-126
R263	1K	550-053
R264	470	550-052
R265	470	550-052
R266	100K	550-127
R267	100K	550-127
R268	10K	550-101
R269	10K, Potentiometer	554-026
R270	10K	550-101
R271	10K	550-101

SWITCHES (Unwired)

S201	3 Pole, 5 Position, Rotary	A76207
S202	2 Pole, 4 Position, Rotary	A76208, Rev. A
S203	2 Pole, 2 Position, Lever	870-002

TRANSFORMER

T1	Pulse Transformer, 1:1:1 Turns Ratio, 140 Millihenries Pulse Engineering Co. PE-2477	900-003

TUBES

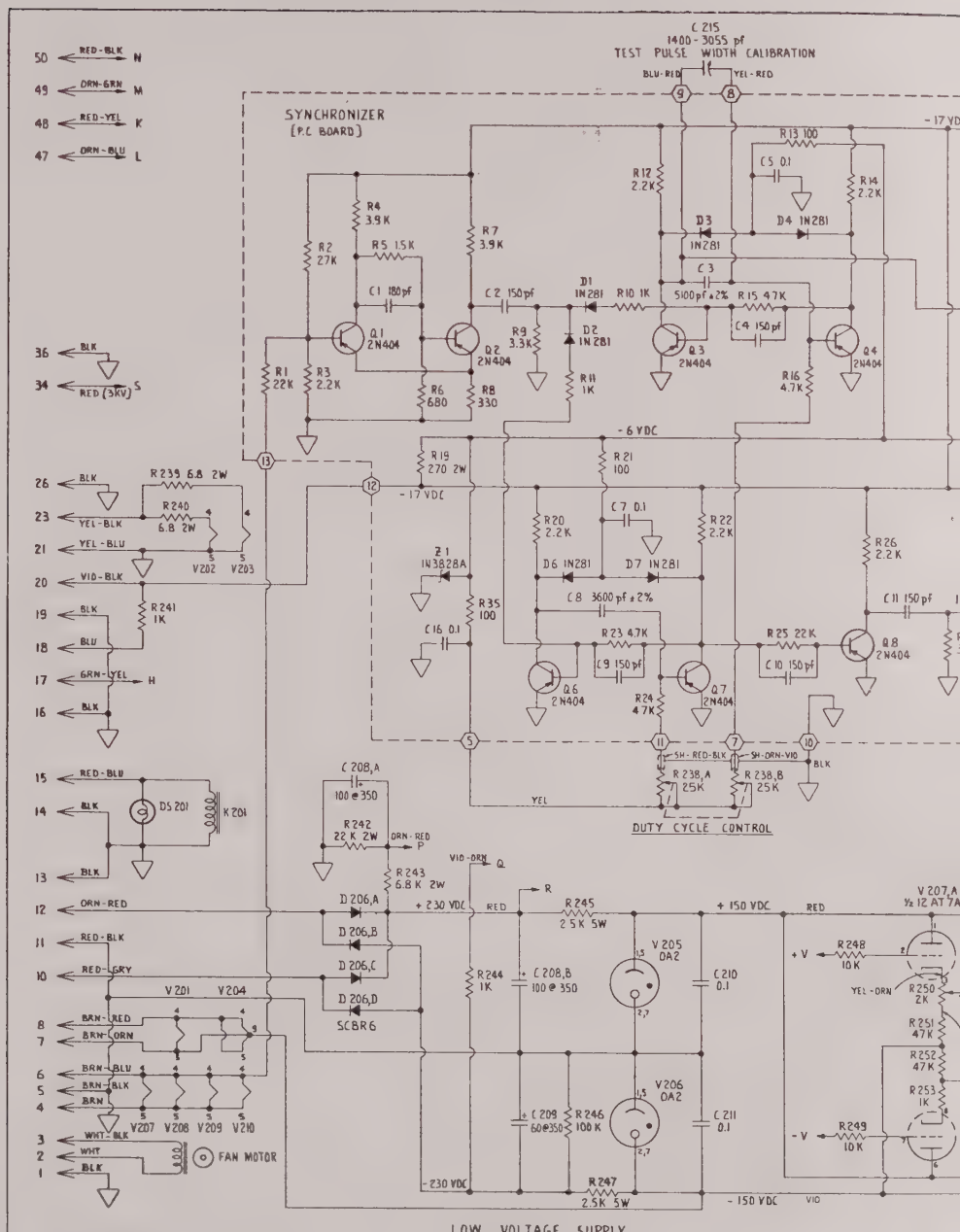
V201	6AN8A	910-104
V202	22JG6	910-175
V203	22JG6	910-175
V204	12AT7A	910-155
V205	OA2	910-000
V206	OA2	910-000
V207	12AT7A	910-155
V208	12AX7A	910-150
V209	12AT7A	910-155
V210	12AX7A	910-150

ZENER DIODES

Z1	1N3828A	740-018
Z2	Hoffman RT-6	740-014
Z3	Hoffman RT-6	740-014

MISCELLANEOUS

Fan Motor		410-000
Fan Blade		250-000
Module Connector,	Amphenol 57-10500	140-001
Test Jacks	E. F. Johnson 111-103	030-000



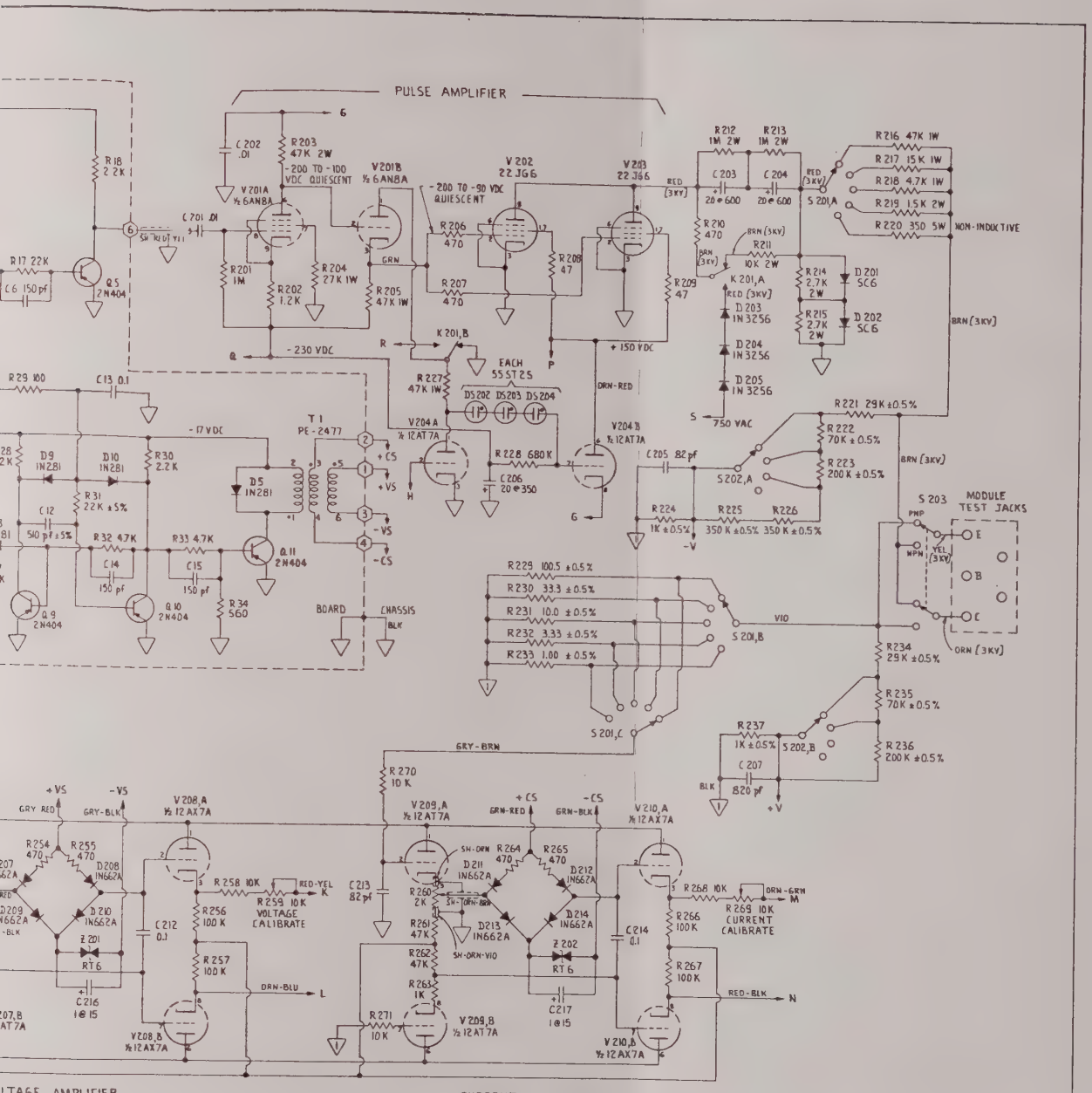
LOW VOLTAGE SUPPLY

6. WIRE COLORS FOR TRACER ONLY, ALL BODY COLORS ARE WHITE
5. WIRE COLORS ARE FOR UNITS WITH SERIAL NUMBERS 2006 UP ONLY
4. SHIELDS GROUNDED.
3. ROTARY SWITCHES SHOWN IN MOST CCW POSITION
2. CAPACITANCES IN μfd @ 500 V.
1. RESISTORS, ½ W, ±10%, CARBON

NOTES: UNLESS OTHERWISE SPECIFIED

FRONT PANEL CONTROLS

S 201	CURRENT RANGE
S 202	VOLTAGE RANGE
S 203	POLARITY
R 238	DUTY CYCLE CONTROL
R 250	ZERO ADJUST (VOLTAGE
R 260	ZERO ADJUST (CURRENT
DS 201	WARNING LAMP (HIGH VOL



VOLTAGE AMPLIFIER

CURRENT AMPLIFIER

REV.	DESCRIPTION	DATE	DRAWN	APP'D
B	0.5% RESISTORS WERE 1%	8-4-65	L.H.A.	
A	ADDED FAN MOTOR	7-16-65	E.B.	

THE BIRTCHER CORP. — INDUSTRIAL DIVISION.

SCHEMATIC

PULSED BREAKDOWN VOLTAGE TEST MODULE

TYPE 10-L

DRAWN: E. Bodeman. DATE: 5-7-65

APP'D: DATE: 5-10-65

REV. B

DIST 6

WARRANTY

All our products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing parts which prove to be defective during the warranty period. We are not liable for consequential damage.

For assistance of any kind, including help with instruments under warranty, contact your authorized Birtcher sales representative for instructions. Give full details of the difficulty and include the instrument model and serial number. Service data or shipping instructions will be promptly sent to you. There will be no charge for repair of instruments under warranty, except transportation charges. Estimates of charges for non-warranty or other service work will always be supplied if requested before work begins.

Serial Number 2135

No. 52503
Amberg
A Boorum & Pease Co.